Ch-22 (23)

LAB - VISUALIZING POTENTIAL FIELDS BETWEEN CHARGES

(Illustrating + charges) (This exercise is due to Vol 35, page 95, Feb 97 issue of *The Physics Teacher*)

NAME: _____

PURPOSE: The purpose of this exercise is to allow you to get a three dimensional graph of what is called the electric potential of the force field around first one, then two or three charges of like or unlike signs.

SETUP: You will need a computer with the spreadsheet Excel. The lab is done entirely on the spreadsheet. Open Excel. Select and highlight cells from column A to AD and down to row 30. This will give you a grid 30 x 30 to work with. With the cells highlighted, go to **Format, Column, width…**, and then type in 3 for the width of each highlighted cell. This will produce a grid that has cells that are square.

In the top left cell, A1, carefully type in the following formula:

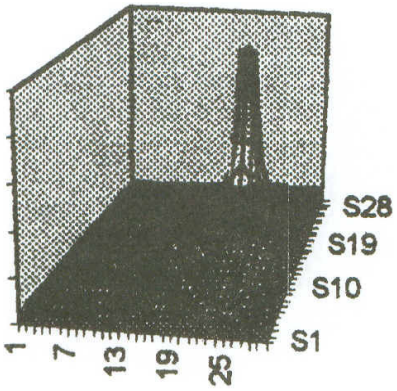
=charge1/SQRT((COLUMN(A1)-COLUMN(charge1))^2+(ROW(A1)-ROW(charge1))^2)

"charge1" will eventually be the name of a particular cell of your choosing For the time being that cell is not named and you will see the error message ### in the cell after you press the Enter key. Don't worry about that yet.

Copy the formula into the rest of the grid. You can do this by clicking in cell A1, and then move the cursor to the lower right corner of the cell until the cursor changes to a solid black cross. Drag the mouse across the cells in the top row to cell AD1. Release the mouse button. Move the cursor to the lower right corner of this last cell, and drag the mouse down to row 30. This will give you an entire grid with the error message, ###.

Click on a cell somewhere near the right edge of the grid. Cell W15 will work well. Type the number 10 and enter it into that cell. Click back on that cell and move the mouse cursor into the naming field which is located in the title bar at the extreme left just below the Font field box. It will have W15 in the box. Click in that box and type charge1. The grid should now change to all numbers.

PART I - PROCEDURE: Double click in the box called Sheet! at the bottom of the screen. In the pop up menu you can now type in DATA and this will name the sheet. Similarly name Sheet2 as CHART. You can now select and highlight the entire grid. Once this is done, click on the Chart Wizard icon in the title bar. The entire selection will now have a moving dotted line around the edge to indicate you have selected it. Click on the tab you have labeled as CHART. When you get there, use the mouse to draw a chart outline with the mouse that just fills the screen. In the nex1 series of pop up dialog boxes select a 3-D surface chart and have no legend. The graph should look something like the picture below.



If you now double click on the chart itself, followed by a single click, small black squares will appear in the comers of the chart. These are handles you can click on with the mouse and rotate the chart to any view you like. Move the cursor to any corner until it changes to a black cross. You can now use the mouse to drag the chart to any orientation you wish. Try it. When you get a view you like, you may wish to print out a copy for your final report.

Next you can try different values of the charge amount, including negative charges. You can reasonably use numbers between 0 and SO. When you have finished, click outside of the chart and go back to the DATA sheet.

PART II - PROCEDURE: The next step is to create a chart that shows the potential between two charges. To do this, click in cell Al and up in the formula bar, highlight the entire formula and copy the formula by clicking on the Copy icon in the title bar. From here, click at the end of the formula, type a + symbol, and paste the formula at the end of the original formula. Delete the second = symbol. Change the second "charge1" parts of the formula to "charge2" in three places. The formula should now look like this:

=charge1/SQRT((COLUMN(A1)-COLUMN(charge1))^2+(ROW(A1)-ROW(charge1))^2)+Charge2/SQRT((COLUMN(A1)-COLUMN(charge2))^2+(ROW(A1)-ROW(charge2))^2).

As you did before, copy the formula into the rest of the grid. You can do this by clicking in cell AI, and then move the cursor to the lower right comer of the cell until the cursor changes to a solid black cross. Drag the mouse across the cells in the top row to cell AD 1. Release the mouse button. Move the cursor to the lower right comer of this last cell, and drag the mouse down to row 30. You will get an error message that says you cannot resolve "Circular references". Just click OK. This will give you an entire grid with the error message, ###.

Click back on W15 (or whichever cell you choose) and type 10 again as a value for charge1. Click on a cell somewhere near the left edge of the grid. Cell L15 will work well. Type the number 10 **(or some number from -50 to +50)** and enter it into that cell. Click back on that cell and move the mouse cursor into the naming field which is located in the title bar at the extreme left just below the Font field box. Click in that box and type cbarge2. The grid should now change to all numbers.

Click on the CHART tab to see the new potential field. As before you can rotate the chart to any reasonable position you want.

PART III - PROCEDURE: You can set up the chart to show the potential field between three charges. Copy the first section of the cell formula again and add it to the end of the formula in cell Al as you did before. Change the last three references of charge1 to charge3. You will have to go through the process of copying the formula into the entire grid and retyping values into cells WI5 and LI5. Pick a cell to name charge3, such as Q8, and then type in a value of your choice for the charge amount. The grid should then change to numbers and the CHART will automatically update. Print out a copy of your best and final chart.

If you are really adventuresome, you can print out *slightly* different views of the same chart and place the printouts under a special viewer I have that will give you a true three dimensional view.